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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/719,294	11/21/2003	Richard Edward Matick	YOR920030324US1	3009

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11/18/2005

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EXAMINER

PATEL, HETUL B

ART UNIT

PAPER NUMBER

2186

DATE MAILED: 11/18/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	Application No. 10/719,294	Applicant(s) MATICK ET AL.	
	Examiner Hetul Patel	Art Unit 2186	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 03 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 21 November 2003.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6, 11, 13-18, 23 and 25 is/are rejected.
- 7) ☒ Claim(s) 7-10, 12, 19-22 and 24 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 07 January 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### DETAILED ACTION

1. Claims 1-25 are presented for examination.

#### ***Claim Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1-6, 11, 13-18, 23 and 25 are rejected under 35 U.S.C. 102(e) as being anticipated by Wilkerson (USPN: 2005/0015555).

As per claim 1, Wilkerson teaches a method allowing a choice of Least Frequently Used (LFU) or Most Frequently Used (MFU) cache line replacement (i.e. allowing LFU cache replacement algorithm), the method comprising the steps of: determining new state information (i.e. new number of times the cache line being read/hit) for at least two given cache lines of a plurality of cache lines in a cache (i.e. *at least two* cache lines have to be examined to find out which cache line is the most frequently used compare to other cache line(s)), the new state information based at least in part on prior state information for the at least two given cache lines (i.e. new number of times the cache line being read/hit is always based on the prior number of hits); and when an access miss occurs in one of the at least two given lines: selecting

either LFU or MFU replacement criteria (i.e. selecting the MFU replacement criteria); and replacing one of the at least two given cache lines based on the new state information and the selected replacement criteria (e.g. see paragraph [0022]).

As per claim 2, Wilkerson teaches the claimed invention as described above and furthermore, Wilkerson teaches that the step of selecting further comprises the step of selecting either LFU or MFU replacement criteria based on selection information (i.e. based on counters 220-230 in Fig. 2).

As per claims 3 and 6, Wilkerson teaches the claimed invention as described above and furthermore, Wilkerson teaches that the state information comprises a plurality of line use counters (220-230 in Fig. 2), each line use counter corresponding to one of the plurality of cache lines (i.e. 310 in Fig. 3); and the step of determining new state information further comprises the step of incrementing a given line use counter when a cache line corresponding to the given line use counter is referenced (e.g. see paragraph [0022] and Figs. 2-3).

As per claim 4, Wilkerson teaches the claimed invention as described above and furthermore, Wilkerson teaches that the reference to the cache line corresponding to the given line use counter is a hit reference (i.e. the counter is incremented each time the cache line is referenced and set to zero when the cache line is replaced) (e.g. see paragraph [0022]).

As per claim 5, Wilkerson teaches the claimed invention as described above and furthermore, Wilkerson teaches that the plurality of cache lines (i.e. 310 in Fig. 3) are assigned to a plurality of congruence classes (i.e. SET 1 – SET M in Fig. 1), each

congruence class assigned to at least two of the plurality of cache lines (i.e. blocks 1-N in Fig. 1) (e.g. see paragraph [0011] and Fig. 1), whereby at least two of the line use counters (i.e. 220-230 in Fig. 2) corresponds to a congruence class (e.g. see paragraph [0016] and Fig. 2); the state information further comprises a plurality of congruence class use counters (220-230 in Fig. 2); and the step of determining new state information further comprises the step of incrementing a given one of the plurality of congruence class use counters when a congruence class corresponding to the given congruence class use counter is referenced, wherein each of the plurality of congruence class use counters corresponds to one of the congruence classes (e.g. see paragraph [0022]).

As per claims 11 and 23, Wilkerson teaches the claimed invention as described above and furthermore, Wilkerson teaches that the cache (i.e. 110 in Fig. 1) is an n-way set associative cache, whereby there are n cache lines per congruence class (i.e. set) (e.g. see paragraph [0011] and Fig. 1).

As per claims 13-16, see arguments with respect to the rejection of claims 1-4, respectively. Claims 13-16 are rejected based on the same rationale as the rejection of claims 1-4, respectively.

As per claim 25, Wilkerson teaches a cache (i.e. 110 in Fig. 1) for replacing Most Frequently Used (MFU) cache lines, the cache comprising: a plurality of cache lines (i.e. 310 in Fig. 3); state information (i.e. the number of times the cache line being read/hit) for at least two given cache lines of the plurality of cache lines (i.e. each cache line has a counter, 220-230, associate with it to indicate how many times it is being referenced;

see Figs. 2-3); MFU circuitry adapted: to produce new state information (i.e. new number of times the cache line being read/hit) for the at least two given cache lines in response to an access to one of the at least two given cache lines (i.e. *at least two* cache lines have to be examined to find out which cache line is the most frequently used compare to other cache line(s)); and when a cache miss occurs in one of the at least two given cache lines to determine, based on the new state information, which of the at least two given cache lines is the most frequently used cache line; and replacement circuitry coupled to the MFU circuitry and to the plurality of cache lines, the replacement circuitry adapted to replace the given cache line determined as the most frequently used (e.g. see paragraph [0022] and Figs. 2-3).

### ***Allowable Subject Matter***

3. Claims 7-10, 12, 19-22 and 24 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

### **REASONS FOR ALLOWANCE**

4. The following is an examiner's statement of reasons for allowance:

The prior arts of record do not teach nor suggest, either alone or in combination, all the limitations of the claims of the current invention (claims 7, 9, 12, 19, 21 and 24); particularly as per claims 7, 9, 19 and 21, the plurality of line use counters are also assigned to the plurality of congruence classes, *one line use counter per cache line*

*assigned to a congruence class; and the step of determining new state information further comprises the step of, when one or more of the line use counters corresponding to a given congruence class exceeds a maximum line use counter limit, dividing all of the line use counters corresponding to the given congruence class by an integer.*

Furthermore, none of the prior arts of record teaches nor suggest, either alone or in combination the limitations of claims 12 and 24, the step of determining new state information further comprises the steps of: *inverting a predetermined number of line use counters; selecting, based on the step of selecting either LFU or MFU replacement criteria, either values of the predetermined number of line use counters or the inverted versions of the predetermined number of line use counters*, wherein the values of the predetermined number of line use counters are selected for an LFU calculation and the inverted versions of the predetermined number of line use counters are selected for an MFU calculation; and determining which of the values of the predetermined number of line use counters or the inverted versions of the predetermined number of line use counters is smallest in value.

### **Conclusion**


5. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hetul Patel whose telephone number is 571-272-4184. The examiner can normally be reached on M-F 8-4:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matt Kim can be reached on 571-272-4182. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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**MATTHEW D. ANDERSON**  
**PRIMARY EXAMINER**